

Level 1 (Beginner)		
Title of the Course/Training	Introduction to Additive Manufacturing	
Language of Instruction	English / Local Language	
Level of Course/Training Unit	Technical/Undergraduate/Graduate	
Target Audience	Un-Skilled/Non-Technical/Technical Persons	
Duration	5 Weeks- 40 Hours	
Mode of Delivery	Face-to-face OR ONLINE	
Type of Course/Training Unit	Elective/Compulsory	
Objectives of the Course/Training	Introduction to Additive Manufacturing, AM Processes, AM Design Perspective	
Recommended or Required Reading		
Resources		
Text Books	[Text 1] A guide to Additive Manufacturing, Springer Tracts in Additive Manufacturing, OPEN ACCESS, [Text 2] Additive Manufacturing Technologies, Third Edition, Ed.Springer, Gibson I., Rosen D., Stucker B., Khorasani M.	
Reference Books	[Ref1] A practical guide to design for Additive Manufacturing, Ed. Springer, Olaf Diegel , Axel Nordin , Damien Motte [Ref2] Handbook of sustainability in Additive Manufacturing, Volume 1, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref3] Handbook of sustainability in Additive Manufacturing, Volume 2, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref4] The management of Additive Manufacturing, Enhancing Business Value, Ed. Springer, Mojtaba Khorram Niaki , Fabio Nonino [Ref5] Standards, Quality Control and Measurement Sciences in 3D Printing and Additive Manufacturing, Chee Kai Chua, Chee How Wong and Wai Yee Yeong [Ref6] Modeling and Simulation of Functionalized Materials for Additive Manufacturing and 3D Printing: Continuous and Discrete Media, Ed. Springer, Tarek I. Zohdi [Ref7] Additive Manufacturing - Developments in Training and Education, Ed. Springer, Eujin Pei, Mario Monzón, Alain Bernard Ref 8] Design for Additive Manufacturing (Additive Manufacturing Materials and Technologies) 1st Edition, Martin Leary, Elsevier	
Course/Training Category		
Mathematics and Basic Sciences		20%
Engineering		30%
Engineering Design		20%
Social Sciences		10%
Education		%...
Science		20%
Health		%...
Field		%...
Planned Learning Activities and Teaching Methods		
Activities are given in detail in the section of "Assessment Methods and Criteria" and "Workload Calculation"		
Assessment Methods and Criteria		
In-Term Studies	Quantity	Percentage
Mid-terms Exams	1	20%
Assigments		
Workshop Practices	1	20%
Projects	1	20%
Final Examination	1	40%
Total	4	100%

ECTS Allocated Based on Student Workload			
Activities	Quantity		Total Work Load
Weekly Theoretical Course/Training Hours	13	3	40
Weekly Tutorial Hours	5	3	15
Reading Tasks	5	3	15
Material Design and Implementation	1	5	5
Midterm Exam and Preperation for Midterm Exam	1	10	10
Workshop practices	5	5	25
Final Exam and Preperation for Final Exam	1	10	10
Total Work Load	31	39	Number of ECTS Credits: 120 (5)

Course/Training Learning Outcomes: Upon the successful completion of this course/training, students/attendees will be able to:			
No	Learning Outcomes		
1	Know the basics of additive manufacturing, AM classification and know the differences between the conventional processes		
2	Know the polymer based additive manufacturing methods and their basic principles		
3	Know the metal based additive manufacturing methods and their basic principles		
4	Use CAD software and able to design parts for AM		
5	Know AM process planning, able to support generation and part orientation, related software issues and ready the part to be 3D printed		
Weekly Detailed Course/Training Contents			
Week	Topics (weekly times x hour)	Study Materials	Materials
1	Introduction to Additive Manufacturing: Overview on AM processes: classification of AM processes, The ASTM/ISO classification of Additive Manufacturing Technologies, main characteristics, advantages and manufacturing constraints. (1x4)	[Text 1, 2]	[Ref1], [Ref7]
2	Additive Manufacturing Methods-Polymers: Basic Principles, Material Knowledge, Constraints, Applications (3x3)	[Text 1, 2]	[Ref1]
3	Additive Manufacturing Methods-Metals: Basic Principles, Material Knowledge, Powder Metallurgy, Constraints, Applications (3x3)	[Text 1, 2]	
4	Design for Additive Manufacturing: Main concepts and objectives, basic tools for computer aided design (3D CAD modelling), shape complexity, DfAM Rules, Biomimetic Design Approach. (3x3)	[Text 1, 2]	[Ref1], [Ref5], [Ref 8]
5	Process Planning in Additive Manufacturing: Main concepts on the whole process planning chain (slicing, path-planning, platform optimization, support generation, machine code generation), Use of common AM Software (Cura, Magics, etc.) (3x3)	[Text 1, 2]	[Ref2], [Ref3], [Ref4]

Level 2 (Intermediate)		
Title of the Course/Training	Additive Manufacturing Engineering	
Language of Instruction	English / Local Language	
Level of Course/Training Unit	Technical/Undergraduate/Graduate	
Target Audience	Un-Skilled/Non-Technical/Technical Persons	
Duration	5 Weeks-45 Hours	
Mode of Delivery	Face-to-face OR ONLINE	
Type of Course/Training Unit	Elective/Compulsory	
Objectives of the Course/Training	Basic AM Training and CAD Knowledge	
Recommended or Required Reading		
Resources		
Text Books	[Text 1] A guide to Additive Manufacturing, Springer Tracts in Additive Manufacturing, OPEN ACCESS, [Text 2] Additive Manufacturing Technologies, Third Edition, Ed.Springer, Gibson I., Rosen D., Stucker B., Khorasani M.	
Reference Books	[Ref1] A practical guide to design for Additive Manufacturing, Ed. Springer, Olaf Diegel , Axel Nordin , Damien Motte [Ref2] Handbook of sustainability in Additive Manufacturing, Volume 1, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref3] Handbook of sustainability in Additive Manufacturing, Volume 2, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref4] The management of Additive Manufacturing, Enhancing Business Value, Ed. Springer, Mojtaba Khorram Niaki , Fabio Nonino [Ref5] Standards, Quality Control and Measurement Sciences in 3D Printing and Additive Manufacturing, Chee Kai Chua, Chee How Wong and Wai Yee Yeong [Ref6] Modeling and Simulation of Functionalized Materials for Additive Manufacturing and 3D Printing: Continuous and Discrete Media, Ed. Springer, Tarek I. Zohdi [Ref7] Additive Manufacturing - Developments in Training and Education, Ed. Springer, Eujin Pei, Mario Monzón, Alain Bernard [Ref 8] Design for Additive Manufacturing (Additive Manufacturing Materials and Technologies) 1st Edition, Martin Leary, Elsevier	
Course/Training Category		
Mathematics and Basic Sciences	20%	
Engineering	30%	
Engineering Design	30%	
Social Sciences	%...	
Education	10%	
Science	10%	
Health	%...	
Field	%...	
Planned Learning Activities and Teaching Methods		
Activities are given in detail in the section of "Assessment Methods and Criteria" and "Workload Calculation"		
Assessment Methods and Criteria		
In-Term Studies	Quantity	Percentage
Mid-terms Exams	1	20%
Assignments		
Workshop Practices	1	20%
Projects	1	20%
Final Examination	1	40%
Total		

ECTS Allocated Based on Student Workload			
Activities	Quantity	Duration (Hours)	Total Work Load
Weekly Theoretical Course/Training Hours	15	3	45
Weekly Tutorial Hours	5	3	15
Reading Tasks	5	3	15
Material Design and Implementation	1	5	5
Midterm Exam and Preparation for Midterm Exam	1	10	10
Workshop practices	5	5	25
Final Exam and Preparation for Final Exam	1	10	10
Total Work Load	33	39	Number of ECTS Credits: 125 (5)

Course/Training Learning Outcomes: Upon the successful completion of this course/training, students/attendees will be able to:			
No	Learning Outcomes		
1	Know design for AM methods: generative design, topology optimisation and other design methods		
2	Perform optimisation design methods and perform computer engineering analysis		
3	Perform AM process development and knows the process parameters affects		
4	Perform thermal, mechanical and simulation analysis using AM software		
5	Know GD&T tools for AM, destrutrice and non-destructive testing methods, surface measurements		
Weekly Detailed Course/Training Contents			
Week	Topics (weekly times x hour)	Study Materials	Materials
1	Design for AM: Generative Design, Topology, shape and size Optimisation, lattice design, Reverse Engineering, Biomimetic design (3x3)	[Text1,2]	[Ref1], [Ref6], [Ref 8]
2	Design and Analysis: Mechanical and Thermal Anslysis, Software implementations, Analysis of FEM results (3x3)	[Text1,2]	[Ref1], [Ref 8]
3	Process Development: Process Parameter Selection, part Orientation, support generation, scanning strategies, path planning and process parameter Control (4x3)	[Text1,2]	
4	Process Simulation: Thermal Analysis, Distortion Analysis, strain analysis, support structure analysis, orientation analysis (3x3)	[Text1,2]	[Ref1], [Ref7]
5	Inspection and Quality Control: Non-destructive Testing Methods, Mechanical Testing methods, Microstructural Analysis, SEM, CT Analysis, Surface Topography Measurements Methods, Dimensional and tolerance measurements and analysis (2x3)	[Text1,2]	[Ref2], [Ref3], [Ref4]

Level 3 (Advanced)		
Title of the Course/Training	Additive Manufacturing	
Language of Instruction	English / Local Language	
Level of Course/Training Unit	Technical/Undergraduate/Graduate	
Target Audience	Un-Skilled/Non-Technical/Technical Persons	
Duration	5 Weeks-78 Hours	
Mode of Delivery	Face-to-face /ONLINE	
Type of Course/Training Unit	Elective/Compulsory	
Prerequisites and co-requisites	AM Basics and Qualification at the level of AM Process Engineering	
Recommended or Required Reading		
Text Books	[Text 1] A guide to Additive Manufacturing, Springer Tracts in Additive Manufacturing, OPEN ACCESS, [Text 2] Additive Manufacturing Technologies, Third Edition, Ed.Springer, Gibson I., Rosen D., Stucker B., Khorasani M.	
Reference Books	[Ref 1] A practical guide to design for Additive Manufacturing, Ed. Springer, Olaf Diegel , Axel Nordin , Damien Motte [Ref 2] Handbook of sustainability in Additive Manufacturing, Volume 1, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref 3] Handbook of sustainability in Additive Manufacturing, Volume 2, Ed. Springer, Subramanian Senthilkannan Muthu, Monica Mahesh Savalani [Ref 4] The management of Additive Manufacturing, Enhancing Business Value, Ed. Springer, Mojtaba Khorram Niaki , Fabio Nonino [Ref 5] Standards, Quality Control and Measurement Sciences in 3D Printing and Additive Manufacturing, Chee Kai Chua, Chee How Wong and Wai Yee Yeong [Ref 6] Modeling and Simulation of Functionalized Materials for Additive Manufacturing and 3D Printing: Continuous and Discrete Media, Ed. Springer, Tarek I. Zohdi [Ref 7] Additive Manufacturing - Developments in Training and Education, Ed. Springer, Eujin Pei, Mario Monzón, Alain Bernard	
Course/Training Category		
Mathematics and Basic Sciences		20%
Engineering		30%
Engineering Design		20%
Social Sciences		%...
Education		10%
Science		20%
Health		%...
Field		%...
Planned Learning Activities and Teaching Methods		
Activities are given in detail in the section of "Assessment Methods and Criteria" and "Workload Calculation"		
Assessment Methods and Criteria		
In-Term Studies	Quantity	Percentage
Mid-terms Exams	1	20%
Assignments		
Workshop Practices	1	40%
Projects	1	20%
Final Examination	1	20%
Total		

ECTS Allocated Based on Student Workload			
Activities	Quantity	Duration (Hours)	Total Work Load
Weekly Theoretical Course/Training Hours	15	5	78
Weekly Tutorial Hours	5	3	15
Reading Tasks			
Material Design and Implementation			
Midterm Exam and Preperation for Midterm Exam	1	10	10
Workshop practices		8	24
Final Exam and Preperation for Final Exam	1	10	10
Total Work Load	25	36	Number of ECTS Credits:134 (5)

Course/Training Learning Outcomes: Upon the successful completion of this course/training, students/attendees will be able to:

No	Learning Outcomes
1	Know post-processing methods and determine proper methods for AM technology
2	Know AM standarts and able to perform cost-analysis considering cost units
3	Know advance AM Techniques, materials, AI in AM and enviromental and social impacts
4	Set-up AM machine, Plan AM production steps and prepare AM machine, control and perform whole sequence of production
5	Perform part removal, support removal, sanding and necessary secondary operations

Weekly Detailed Course/Training Contents

Week	Topics (weekly times x hour)	Study Materials	Materials
1	Post-processing Methods: Surface enhancements methods, Heat Treatment, Support Reomoval, Finishing etc. (3x3)	[Text1,2]	[Ref1], [Ref6]
2	AM Standarts & Cost Analysis: Standardization and cost estimation (material, energy, operating etc.) (1x3)	[Text1,2]	[Ref1]
3	Advanced AM Techniques: AI in AM, Micro-Nonao Printing, Bioprinting, 4D Printing, Hybrid AM, FGM and Smart Mataterials, enviromental and social implications (2x3)	[Text1,2]	[Ref7]
4	Practical Application 1: Production Planning & Preparation, industrial and business case models, Process Optimisation and Simulation, Machine Operation, raw material handling (loading and depowdering etc.) (5x6)	[Text1,2]	
5	Practical Application 2: Workshop Production, Post Processing, testing and Inspection, Maintenance of AM machine and its units (5x6)	[Text1,2]	